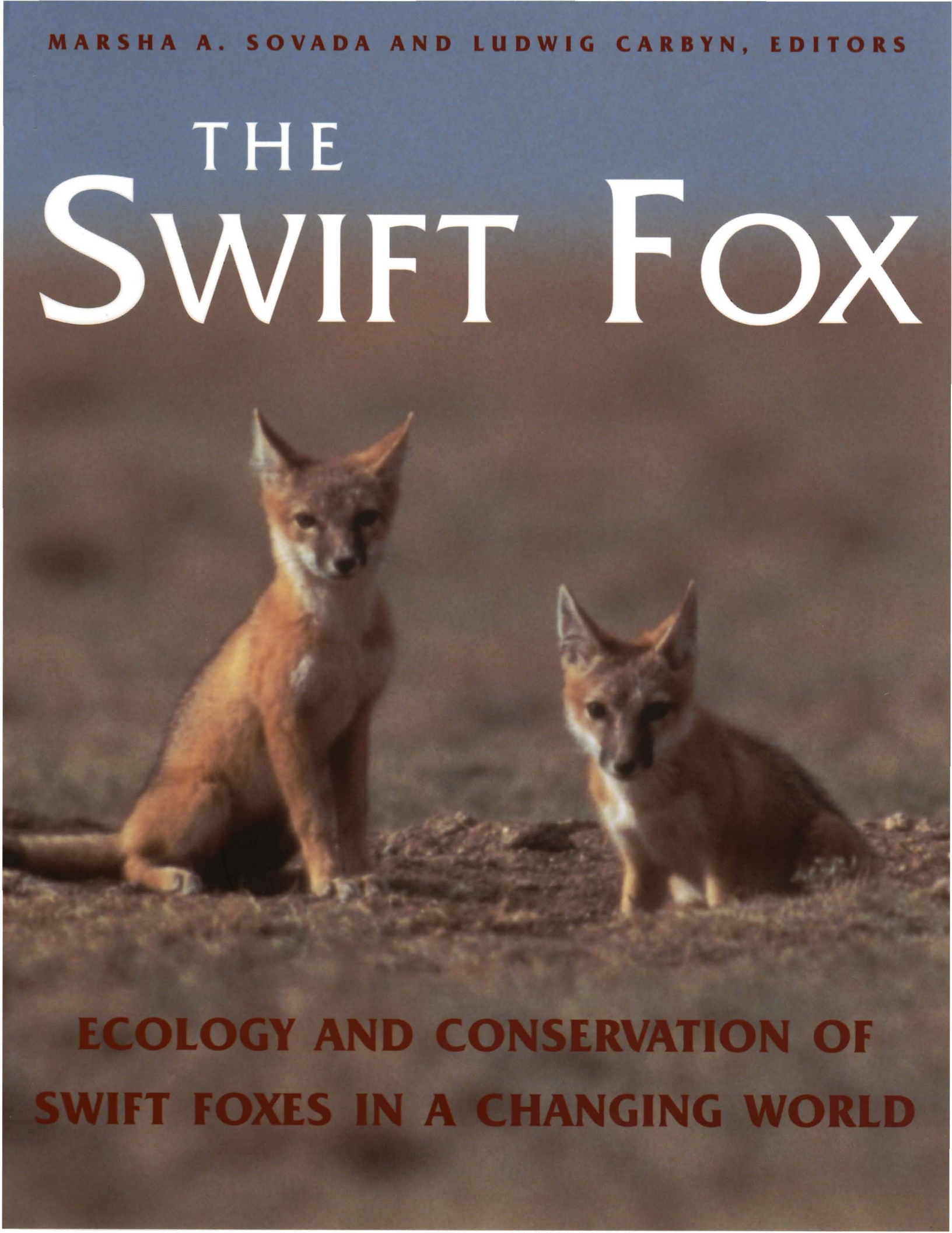
MARSHA A. SOVADA AND LUDWIG CARBYN, EDITORS

THE SWIFT FOX



ECOLOGY AND CONSERVATION OF SWIFT FOXES IN A CHANGING WORLD

A Review of the Ecology, Distribution, and Status of Swift Foxes in the United States

■ David Allardyce and Marsha A. Sovada

Abstract: Swift foxes are native to the shortgrass and mixed-grass prairies of the Great Plains of North America. They are particularly suited to the dynamic conditions of the prairies because they: 1) are opportunistic and generalist foragers, 2) use dens for shelter from extreme climatic conditions (heat and cold) and for protection from predators, and 3) apparently require little or no open water for survival. There is controversy surrounding the taxonomy of swift foxes, i.e., whether there are 2 subspecies (northern and southern range) based on morphological and perhaps behavioral differences. Knowledge of swift fox biology is important for developing strategies to conserve the swift fox and their critical habitats. We provide a review of swift fox ecology, historic distribution, and populations status in the United States and identify potential threats to populations. We include a brief summary of actions taken to conserve the species in the Great Plains Region of the United States.

Taxonomic Status

The swift fox was first described by Thomas Say in James (1823). Say named the fox *Canis velox*, but it was reassigned to the genus *Vulpes* by Audubon and Bachman (1851). Soon afterwards, Merriam (1888) described and named the kit fox (*Vulpes macrotis*). Hall and Kelson (1959) suggested that swift foxes and kit foxes were conspecifics, being subspecifically distinct. Similar conclusions were reported by Dragoo et al. (1990) using morphometric analysis coupled with electrophoretic protein analysis. However, other studies using multivariate morphologic analysis have distinguished swift and kit foxes (Rohwer and Kilgore 1973, Thornton and Creel 1975, Egoscue 1979, McGrew 1979, Stromberg and Boyce 1986). A recent evaluation of taxonomic status, using mitochondrial DNA restriction-site and sequence analyses, concluded that the kit fox and the swift fox should be recognized as separate species (Mercure et al. 1993). They suggested the Rocky Mountains may have been a barrier to gene flow between kit and swift foxes because populations on either side belong to 2 divergent mitochondrial DNA clades. Dragoo and Wayne (2003) suggest that swift fox and kit fox should be considered as one species based on recent microsatellite and mtDNA analysis. For the purposes of this paper, we consider the swift fox as a separate species from the kit fox.

Merriam (1902) classified 2 subspecies of the swift fox as the northern swift fox (*V. v. hebes*) and the southern swift fox (*V. v. velox*). Merriam's classification was still in use when the northern subspecies was listed as endangered in 1970 (Federal Register 1970). The endangered listing was removed in the United States in 1980 (Federal Register 1980); however, this designation remains in Canada (50 CFR 17.11). These subspecific designations have been a point of controversy among taxonomists (see Dragoo and Wayne 2003). Stromberg and Boyce (1986) investigated the question of the existence of 2 subspecies of swift fox (*V. v. velox* and *V. v. hebes*). After examining 250 specimens, they concluded that subspecific classification of the southern swift fox and northern swift fox was probably not justified, although significant geographic variation was noted. These authors suggested that such variation may reflect genetic variation and warrants conservation efforts to preserve genetic diversity, and urged caution in reintroduction programs because of risk of potential loss of genetic adaptation to the severities of northern climates. Dragoo and Wayne (2003) advocate many fewer subspecies classifications of swift and kit foxes, yet agree with the recommendation to limited gene flow between populations to maintain potentially adaptive differences among populations.

Life History and Ecology

Swift foxes seem to be monogamous and likely pair for life (Kilgore 1969). They live in pairs or occasionally as trios or groups of 2 males and 2–3 females, with 1 breeding female and nonbreeding "helpers" (Kilgore 1969, Covell 1992). Swift foxes are monestrous (Asa and Valdespino 1998), with breeding beginning in late December or early January in the southern portion of their range to March in the northern portion of their range (Kilgore 1969, Hines 1980, Carbyn et al. 1994). Gestation is estimated to be 51 days (Hayssen et al. 1993). Average litter sizes of 2.4–5.7 have been reported based on counts of pups at natal dens (Kilgore 1969, Hillman and Sharps 1978, Covell 1992, Carbyn et al. 1994, Roell 1999, Schauster et al. 2000, Andersen et al. 2003). Both members of the pair provide for the young, and young foxes remain with the adults for 4–6 months (Rongstad et al. 1989, Covell 1992), which is longer than other North American canids. Covell (1992) reported that male pups had a higher frequency of dispersal from September–

January (23% versus 10%) and dispersed significantly farther (9.4 km versus 2.1 km) than female pups. In western Kansas, 3 pups radiomarked at dens in August 1996 had dispersed approximately 25 km, 22 km, and 18 km (male, female, female, respectively) by January of 1997 when monitoring ceased (M. Sovada, unpublished data). Four other pups (2 males, 2 females) monitored during the same period remained within 4 km of their natal denning area.

Reported annual mortality rates range from 0.47 to 0.57 (Covell 1992, Sovada et al. 1998, Andersen et al. 2003), which is similar to rates reported for other North American foxes (Lord 1961, Storm et al. 1976, Cypher and Scrivner 1992, Disney and Spiegel 1992, Ralls and White 1995). Coyotes (*Canis latrans*) have been identified as the principal cause of swift fox mortality (Laurion 1988, Covell 1992, Carbyn et al. 1994, Sovada et al. 1998, Kitchen 1999, Andersen et al. 2003). Interference competition rather than a food resource is the likely causal factor based on the infrequent consumption of swift foxes killed by coyotes (Sovada et al. 1998, Kitchen 1999). Both Kitchen (1999) and Andersen et al. (2003) speculated that coyote-caused mortality may suppress fox populations, especially in times of low prey availability. Other predators of swift foxes that have been identified are golden eagles (*Aquila chrysaetos*) and American badgers (*Taxidea taxus*; Carbyn et al. 1994, Andersen et al. 2003). Potential predators include red foxes (*Vulpes vulpes*), bobcats (*Lynx rufus*), large hawks, and great horned owls (*Bubo virginianus*). Mortality factors associated with human activities include vehicle collision, secondary poisoning, shooting, and trapping (Kilgore 1969, Rongstad et al. 1989, Carbyn et al. 1994, Sovada et al. 1998). Collisions with automobiles are a significant mortality factor for young animals in some landscapes (Sovada et al. 1998).

Swift foxes host a variety of internal and external parasites (Kilgore 1969, Pybus and Williams 2003). Fleas (*Pulex spp., Opisocrostos hirsutus*) are the most common and abundant ectoparasite. Kilgore (1969) suggested that the large numbers of fleas found in swift fox dens may contribute to the frequent changes in dens used by foxes. Other parasites include hookworms (*Ancylostoma caninum, Uncinaria* sp.) and whipworms (*Trichuris vulpis*), as well as miscellaneous protozoans and ectoparasite species (Pybus and Williams 2003). There is little known about the occurrence of diseases in swift foxes, however it is likely that swift foxes are susceptible to most diseases that occur in other canids (see Pybus and Williams 2003).

Swift foxes are among the most fossorial members of the North American canid family, and unlike most other canids, dens are used throughout the year (Cutter 1958a, Kilgore 1969, Egoscue 1979, Hines 1980). Swift foxes either excavate their own dens or enlarge the burrows of other animals (Rongstad et al. 1989, Hines and Case 1991). Swift foxes typically use dens daily, have multiple dens, and members of a family group may be found together in a den (Hines and Case 1991, Andersen et al. 2003). Dens are largely located in shortgrass and mixed-grass prairie, although dens also have been found in cultivated fields and other human-made habitats (Cutter 1958a, Kilgore 1969, Uresk and Sharps 1986, Jackson and Choate 2000). Dens serve several functions, such as providing escape cover from predators, protection from extreme climate conditions in both summer and winter, and shelter for raising young (Rongstad et al. 1989, Fox 1991). Notably, the distribution and density of dens which are used for protection from predators are considered important components of swift fox habitat requirements, and may influence predation rates and growth rates of swift fox populations (Herrero et al. 1991, Swift Fox Conservation Team 1997a, Kitchen et al. 1999, Pruss 1999).

Swift foxes are primarily nocturnal, although limited daytime activity may occur near den sites (Kilgore 1969, Laurion 1988, Kitchen et al. 1999, Andersen et al. 2003). Andersen et al. (2003) observed that much of the nighttime activity also occurred near dens. Members of family groups forage separately (Hines and Case 1991), but home ranges of family members are similar (Andersen et al. 2003). Swift foxes tend to travel greater distances in the breeding season (Hines and Case 1991, Kitchen 1999), which Kitchen (1999) speculated would increase potential encounters with coyotes and thus vulnerability to coyote predation. Her observation of higher coyote-caused mortality during the breeding season supports this premise.

There are few quantitative analyses of habitat use by swift fox, although studies have described suitable habitats as shortgrass and mixed-grass prairies in gentle rolling to level terrain (Cutter 1958a, Kilgore 1969, Hillman and Sharps 1978, Hines 1980). Kitchen (1999) found swift foxes only in open plains habitat, and did not capture any foxes or observe their activity in nearby piñón pine-juniper habitat. Additional favorable conditions likely include low potential for contact with human activities and low densities of predators such as coyotes (Hillman and Sharps 1978).

Published estimates of swift fox home ranges are quite variable and difficult to compare because different techniques and criteria were used to estimate home-range size. Hines and Case (1991) reported an average home-range size of 32.3 km^2 (range 7.7–79.3 km^2) for 7 swift foxes in Nebraska using minimum convex polygon method (MCP; Mohr 1947), but 4 animals were followed ≤5 nights in winter or very early spring. Andersen et al. (2003) reported a similar average MCP home-range size of 29.0 km^2 (range 12.8–34.3 km^2) on the Piñón Canyon Maneuver Site in southeastern Colorado (1986–87) for 5 swift foxes with ≥34 locations ($\bar{x}$ = 188 locations) over minimum period of 7 months. A smaller estimate (MCP) of average home range, 25.1 km^2 (range 8.7–43.0 km^2), was determined for 22 swift foxes in western Kansas (Sovada, unpublished data) using only foxes with >60 locations. Zimmerman et

al. (2003) estimated average MCP home-range size of 10.4 km^2 (range 7.3–16.9 km^2) for 5 swift foxes in Montana. Using the 95% adaptive kernel method (Worton 1989), Kitchen et al. (1999) reported average home-range size of 7.6 km^2 for foxes (with >60 locations per season) on the Piñón Canyon Maneuver Site during 1997–98. Early studies suggested that swift foxes were not territorial (Hines 1980, Cameron 1984), although more recent data have provided evidence of territoriality. Andersen et al. (2003) reported nearly total exclusion of an individual swift fox's core activity area to other same-sex individuals.

Swift foxes, like other canids, are opportunistic foragers, feeding on a wide variety of mammals, birds, arthropods, plants and carrion (Cutter 1958b, Kilgore 1969, Hillman and Sharps 1978, Zumbaugh et al. 1985, Uresk and Sharps 1986, Hines and Case 1991, Kitchen et al. 1999, Sovada et al. 2001). Mammals usually dominate swift fox diets; especially important are lagomorphs (Cutter 1958b, Kilgore 1969, Cameron 1984, Hines and Case 1991) and rodents (Uresk and Sharps 1986, Kitchen et al. 1999). Insects and birds become important food items in late summer and early fall (Uresk and Sharps 1986, Kitchen et al. 1999); several studies have reported use of carrion throughout the year (Kilgore 1969, Zumbaugh et al. 1985, Uresk and Sharps 1986, Hines and Case 1991). The generalist foraging behavior of swift foxes makes food an unlikely limiting factor, yet there is no evidence to refute or support food availability as a factor limiting populations. Evidence from kit foxes suggests that food scarcity may result in temporary or local declines (White and Ralls 1993). Kitchen (1999) speculated that increased distances traveled and time spent foraging during periods of limited food availability may increase vulnerability of swift foxes to coyote-caused mortality and may contribute to population decline.

Historic Distribution

The swift fox is native to the shortgrass and mixed-grass prairies of the Great Plains Region of North America (Egoscue 1979), and historically occurred in all or portions of North Dakota, South Dakota, Montana, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas and the southern prairie region of Alberta, Manitoba, and Saskatchewan (Hall and Kelson 1959, Banfield 1974, Egoscue 1979, Sovada and Scheick 1999).

The historic distribution of the swift fox in the Great Plains has been based on limited information found in museum and fur-trade records and by accounts of early naturalists and explorers. This information about historic distribution is especially fragmentary and not all observations can be verified. Many contemporary biologists (Swift Fox Conservation Team 1997a) believe that the historic swift fox distribution was influenced by and likely restricted to the expanse of shortgrass and mixed-grass prairie (see Risser et al. 1981). This assessment is largely based on observations of swift fox behaviors, habitat use, and locations of confirmed records. The eastern boundary of the historic distribution of swift foxes remains particularly unclear, which may be attributed to the naturally shifting geographic boundary between the mixed-grass and tall grass prairies; this shifting largely occurred as a result of climatic variations (Küchler 1972, 1985; Weaver et al. 1996). Thus, swift fox distribution in the east may have shifted with the changing boundary between the mixed-grass and tall grass prairies. In the southern portion of the historical range, in extreme western Texas and New Mexico, the swift fox range overlapped with that of the kit fox, and hybridization between the 2 species apparently occurred along the Pecos River (Hall and Kelson 1959, Rohwer and Kilgore 1973, Mercure et al. 1993). It is important to note, as Hubbard (1994) reported, that the contact zone between swift and kit foxes "is as enduring as it is broad," existing for several thousand years, yet abrupt morphological differences between swift and kit foxes exist in this zone.

Some historical range descriptions include swift foxes in Minnesota and Iowa, however, there are no verifiable records of swift fox occurrence in either state (Dinsmore 1994; E. Birney, Bell Museum of Natural History, University of Minnesota, personal communication). Swanson et al. (1945) suggested swift foxes may have occasionally ventured into Minnesota based on their occurrence only 56 km west of Minnesota, as reported in Alexander Henry's journals (Reid and Gannon 1928). Similarly in Iowa, there are only second-hand reports of swift fox observations (Dinsmore 1994). Furthermore, no records of swift foxes have been confirmed for counties in South Dakota or Nebraska adjacent to Iowa. Minnesota and Iowa may have been on the fringe of swift fox range, with foxes venturing into these states intermittently and at low densities.

The first published record of the swift fox was in 1801 from Alexander Henry's fur shipment records, from Pembina Post of the Northwest Company's Red River District (Reid and Gannon 1928) in North Dakota. The main post was located at the junction of the Pembina and Red rivers, with branch posts to the west in the Hair Hills (Pembina Hills) and the mouth of the Reed River in Canada. Alexander Henry's journals do not identify exact trapping locations, but rather likely reflect the locations where fox pelts were traded. Specifically, there is no mention of swift or kit foxes in Henry's journals, only references to red foxes. "Kit" (swift) foxes were only noted in tabulation of yearly acquisitions (Reid and Gannon 1928). The small number taken in the 8 years of trapping records suggests swift foxes were not common in the vicinity of northeastern North Dakota during Henry's operation at the Pembina Post. Moreover, Reid and Gannon (1928) suggested that swift foxes likely were not common in

northeastern North Dakota, stating "...being a plains animal it is quite probable they were more common farther west." However, Bailey (1926) quotes Charles Cavileer from "A Story of '53" describing the fur-trade in Walhalla, as obtaining 400–600 "kit foxes" per year from the Pembina mountain region for a period before the American bison (*Bison bison*) disappeared.

John James Audubon reported swift foxes near Fort Clark in North Dakota in 1833 (*in* Bailey 1926) and again in 1843 (Audubon and Bachman 1854). In 1850, Thaddeus A. Culbertson collected a specimen near Fort Union (Bailey 1926). F.V. Hayden (1862 *in* Bailey 1926) reported capturing 50–100 swift foxes each winter near each of the trading posts along the Missouri River. Elliot Coues reported swift foxes as "common" along the Souris (Mouse) River (*in* Bailey 1926) and collected 5 specimens now located in the National Museum (Washington, D.C.). In a report from an 1873 military expedition from Fort Rice (on the Missouri River near the geographic center of North Dakota) due west to and along the Musselshell River to the Yellowstone River, Allen (1874) described swift foxes as "quite frequent." George B. Grinnell (1914, *in* Knowles et al. 2003) found swift foxes abundant along the Little Missouri in 1874. Ludlow (1875) traveled from Fort Lincoln (near present-day Mandan, North Dakota) to the Black Hills of South Dakota, and described swift foxes as "abundant everywhere on the plains," though not often seen, because of its small size and furtive disposition, in preference to running.

All of South Dakota was historically considered as part of the range of the swift fox (Over and Churchill 1941, Hall and Kelson 1959, Egoscue 1979, Hall 1981); however, E. Birney, (Bell Museum of Natural History, University of Minnesota, Minneapolis, personal communication) and J. Knox Jones (Texas Tech University, Lubbock) could find no record of swift foxes in the easternmost counties of South Dakota while researching for their 1988 book, *Mammals of the North-central States*. Archeological remains were found at the Mobridge site (ca. 1650–1700) and the Walth Bay site (ca. 1550–1600), both in Walworth County (K. Lippincott, South Dakota Archeological Consultant, Pierre, personal communication). Perhaps the first published account of swift foxes in South Dakota was from Pierre-Antoine Tabeau, a member of a fur-trading expedition from St. Louis to the upper Missouri River from 1803–1805, who observed both red and "a kind of little gray fox" (presumably swift fox) as very common in the upper Missouri (*in* Abel 1939). Large numbers of swift fox pelts were traded at the American Fur Company's Upper Missouri Outfit (near the confluence of the Big Sioux and Missouri rivers) from 1835–1838 (Johnson 1969). Ludlow (1875) reported that swift foxes were "abundant" on the plains while he was traveling from Fort Lincoln, North Dakota, through Corson and Harding counties, South Dakota, to the Black Hills. Visher (1914) described swift fox as present but very rare in Harding County, but noted that furbearer trapping reports were dependent on bounty prices. The Smithsonian Institution records show a specimen collected northwest of Pierre, Hughes County, in 1917 (USNM 300300). This record is the easternmost historic record that we could find for the state of South Dakota.

The swift fox was thought to occur in much of Nebraska prior to European settlement (Jones 1964, Hines and Case 1980, Hall 1981). However, much of the far eastern portion of Nebraska was considered tall grass prairie (Risser et al. 1981), which is inconsistent with habitat typically occupied by swift foxes. There are few historic records of swift foxes in Nebraska (Sovada and Scheick 1999). Cary (1902) reported that swift foxes "occur sparingly" in the Hat Creek Basin in northwestern Nebraska.

Zumbaugh and Choate (1985) reviewed historical accounts of the swift fox in Kansas. The swift fox occurred in at least 36 counties and perhaps 44 counties (including verified and unverified records) throughout most of the western half of the state in shortgrass and mixed-grass prairie habitat (Carter 1939 *in* Zumbaugh and Choate 1985, Hall and Kelson 1959, Bee et al. 1981, Zumbaugh and Choate 1985, Fox and Roy 1996).

In Oklahoma, the swift fox was considered to occur historically throughout the panhandle region (Cimarron, Texas, and Beaver counties) and western portions of three adjacent counties (Harper, Woodward, and Ellis counties; Duck and Fletcher 1945, Hall 1981, Caire et al. 1989).

Reports from 2 early expeditions to parts of Oklahoma, excluding the panhandle, did not include presence of swift foxes in their observations of mammals, suggesting that swift foxes did not historically occur in other parts of Oklahoma. In the first expedition in 1835, Washington Irving joined a military expedition from Fort Gibson (northeast Oklahoma) to the center of the state. In his book *A Tour of the Prairies*, Irving (1835) did not note the presence of swift foxes in his accounting of mammals. In 1852, Captain Randolph B. Marcy explored the Red River, which defines the present southern border of Oklahoma. Marcy's list of mammals encountered did not include swift foxes (Marcy 1854).

The first record of swift fox occurrence in Oklahoma was in 1888 located in the "Neutral Strip" (panhandle; Caire et al. 1989). Several agencies conducted biological explorations of the lands that were opened to settlers during the land runs of 1889 and 1893. Charles P. Rowley led a party from the American Museum of Natural History that spent several weeks in October and November 1889 in the western part of the panhandle collecting American bison. The party also collected a number of small mammals near Corrumpa and Seneca creeks in the southwestern part of present-day Cimarron County, but they did not note swift foxes. Similarly, from the same period, collections in Wood County for the Field Museum of Natural History in

Chicago, and in Woodward County for the U.S. Bureau of the Biological Survey made no mention of swift foxes.

Bailey (1905) provided the first published report of swift foxes in Texas, reporting swift foxes in Stanton, Martin, Midland, Oldham, and Armstrong counties. Egoscue (1979), Hall (1981), and Jones et al. (1987) defined the historic range of the swift fox in Texas to include the panhandle region south into the west-central portion of the state; approximately 78 counties were included. Jones et al. (1987) indicated only 28 counties in Texas had reliable records of swift fox based on the literature, trapping records, or museum specimens, and they estimated that half of the historic range of the swift fox in Texas (high plains below the 34th parallel) was no longer suitable for swift foxes due to intensive agriculture. Our accounting of historical and current records include swift foxes in 26 counties with another observation from the convergence of Crane, Pecos and Upton counties (see Sovada and Scheick 1999). Certainly foxes occurred in other counties lacking recorded observations or specimens, but the striking absence of records from the grassland type of Southern Mixed-Grass Prairie with Shrubs (Risser et al. 1981; *see* Sovada and Scheick 1999) suggests this shrubby grassland habitat may be less suitable for swift foxes. Similar to the shifting nature of the boundary between mixed-grass and tall grass prairies described above, encroachment of shrubs in the southern mixed-grass prairie (Archer 1994) may have influenced swift fox distribution.

Historically, the swift fox was considered common in the shortgrass to mixed-grass prairies east of the Rocky Mountains of Montana (Swift Fox Conservation Team 1997a, Knowles et al. 2003). Meriwether Lewis and William Clark observed swift foxes along the Marias and Missouri rivers in 1805 and 1806 (Burroughs 1961). In the late 1800s, Coues (1878) reported that swift foxes were common between the Milk River and the Canadian border. There are many other reports of swift foxes in Montana in the late 1800s and early 1900s (e.g., Audubon and Bachman 1854, Allen 1874, Custer 1875, McChesney 1879; see Knowles et al. 2003). The last historical record of swift foxes in Montana was in 1918, when Bailey and Bailey (1918) noted the swift fox commonly occurring on the plains along the eastern edge of Glacier National Park. Hall and Kelson (1959) indicated the range of the species crossed the mountains of western Montana and extended into British Columbia. This determination was contradicted by Soper (1964) and Hoffmann et al. (1969), who did not list the species as part of British Columbia's fauna. Banfield (1974) describes Canadian distribution at the time of settlement as the southern prairies of Canada from the Pembina Hills of Manitoba to the foothills of the Rocky Mountains.

In Wyoming and Colorado, swift foxes originally occupied the short and mixed-grass prairie regions in the eastern halves of each state (Cary 1911, Long 1965, Armstrong 1972, Hall 1981, Lindberg 1986). Distribution in Wyoming included all or portions of 17 counties; historic records defined the western edge of distribution along the eastern portions of Big Horn, Washakie, Freemont, and Sweetwater counties (Long 1965, Hall 1981, Lindberg 1986). Cary (1911) described accounts of swift foxes as far west as Boulder County in central Colorado.

In New Mexico, swift foxes likely occurred in 12 counties including Colfax, Union, Mora, Harding, San Miguel, Guadalupe, Quay, De Baca, Curry, Roosevelt, Chaves, and Lea (Swift Fox Conservation Team 1997a); vegetative classification in this region was Plains-Mesa Grasslands (Dick-Peddie 1993). Bailey (1931), Egoscue (1979), and Hall (1981) described the species as occurring east of the Pecos River drainage in the extreme eastern portion of New Mexico. There are no records from 1894 to 1952, except for a report from Santa Rosa labeled *V. macrotis*, which Bailey (1931) believed was *V. velox*; and a museum record (Museum of Southwest Biology [MSB], University of New Mexico, #BRD101289) from a fox collected 13 km southwest of Albuquerque, which is substantially outside of the accepted historic range of the swift fox. Further examination of this specimen has identified it as *V. macrotis* (Robert Harrison, University of New Mexico, Albuquerque, personal communication).

Status of Populations

The swift fox was considered common or abundant in much of its original range until the late 1800s to the early 1900s. Records of the American Fur Company's Upper Missouri Outfit (near the confluence of the Big Sioux and Missouri Rivers) from 1835 to 1838 included 10,427 swift fox pelts compared to 1,051 red fox pelts and 13 gray fox (*Urocyon cinereoargenteus*) pelts received during the same period (Johnson 1969). Alexander Henry's journals noted the take of 117 "kit" foxes from 1800 to 1806 in northeastern North Dakota with an additional 120 "kit" foxes received from the Hudson's Bay Company at Pembina in 1905–1906 (Reid and Gannon 1928).

Swift fox numbers and distribution declined dramatically by the late 1800s and early 1900s. Zumbaugh and Choate (1985) provided evidence that, in Kansas, swift foxes were extremely abundant in the mid-1800s, but became less abundant by the turn of the twentieth century. The decline continued and there were only sporadic reports in the 1930s (Carter 1939, Tihen and Sprague 1939). The species was believed to have been extirpated from Kansas by the 1940s (Black 1937, Cockrum 1952, Hall 1955, Sovada and Scheick 1999). Jones (1964) suggested that the swift fox may have been extirpated from Nebraska by the early 1900s because there were no records from 1901 (Merritt Cary, Manuscript on file, U.S. Fish and Wildlife Service, Washington, D.C., *in* Jones

1964) to 1953–54, when a female and 2 pups were taken in Morril County near Bridgeport. Blair (1939) did not list any known records of swift fox in Oklahoma. In the panhandle of Oklahoma, Duck and Fletcher (1945) reported that "in earlier days it [swift fox] was frequently seen throughout this area," but noted that they were "very rare" in 1945. Cockrum (1952) considered them extinct in Oklahoma. Bailey (1905) noted that Texas ranchers indicated that swift foxes were scarce compared to their numbers in previous years. A specimen from Armstrong County in 1905 (Bailey 1905) was the last recorded swift fox in Texas until 1948, when one was collected in Swisher County (Glass 1956). By 1900, swift fox range had contracted significantly in Colorado (Cary 1911, Lechleitner 1969, Armstrong 1972, Hall 1981), yet Cary (1911) reported that swift foxes were common in many Colorado counties. In 1915–1916, swift foxes were collected in Adams and Las Animas counties, but there was no subsequent documentation in the state until 1941 in Crowley County (*see* Sovada and Scheick 1999). In Montana, the lack of confirmed records since the report of Bailey and Bailey (1918) and no records of swift fox occurrence in 16 years of fur harvest data prompted Hoffmann et al. (1969) to conclude the species was probably extinct in Montana. In Wyoming, swift fox numbers began a marked decline by the late 1800s, and there are no reports of swift foxes from 1898 until a report from Laramie County in 1958 (Long 1965). There were no reports of swift foxes in South Dakota between 1914 and 1966 (Hillman and Sharps 1978), in North Dakota between 1915 and 1970 (Pfeifer and Hibbard 1970), and in Nebraska between 1901 and 1953 or 1954 (Jones 1964). Swift foxes were last seen in Canada in 1938 (Soper 1964); the last confirmed specimen came from near Govenlock, Saskatchewan in 1928 (Carbyn 1998).

Many factors have been attributed to the population decline of the swift fox that followed the arrival of European settlers to the prairie regions (Zumbaugh and Choate 1985, Scott-Brown et al. 1987). Perhaps the most important direct cause of swift fox population decline was inadvertent poisoning from strychnine-laced baits, which were widely used to control gray wolves (*Canis lupus*) in western North America (Seton 1909, Young 1944). Swift foxes readily accepted poisoned baits and thus died by the thousands (Bailey 1926, Young 1944). Grinnell (1914) commented on taking 3000 "wolves" (1/4 gray wolves and 3/4 coyotes), as well as "several bales" of swift fox skins, during a poisoning campaign in Rush County, Kansas, during 1860–1861. Intense trapping was another factor contributing to declines in swift fox populations. Hudson's Bay Company records showed that 117,025 swift fox pelts were sold in London between 1853 and 1877 (Rand 1948). In Canada, commercial trapping of swift foxes continued into the early 1900s, but with appreciably lower success; only 508 pelts were sold from all of the Canadian prairie provinces in 1925.

Modification, degradation, loss, and fragmentation of native grasslands and the associated declines in prey species also have been implicated in the decline of swift foxes (Egoscue 1979). The settlers converted large expanses of prairies to cropland (Samson and Knopf 1994, Samson et al. 1998), first in much of the tall grass prairie and later in portions of the mixed-grass prairie. The drier areas of shortgrass prairie were less suitable for grain farming but were suitable for cattle production. However, despite less conversion of native prairies to cropland in the shortgrass prairies (Samson et al. 1998), native grazers such as American bison and prairie dogs (*Cynomys* spp.) were largely replaced by domestic cattle, which have very different grazing behaviors (Schwartz and Ellis 1981). It is unknown how this change affected swift foxes and their habitat requisites. Furthermore, northern populations of swift foxes may have relied more heavily on carrion, such as bison killed by gray wolves or dying from natural causes, to survive severe winter months. This substantial food source was no longer available once wolves and bison were eradicated from the region (Carbyn 1986, Klausz et al. 1996). While suffering declines in northern and eastern parts of their range, swift fox populations were able to persist in the southwestern portion of their historical range.

Swift fox numbers appeared to be recovering over portions of their former range beginning in the 1950s (Martin and Sternberg 1955, Glass 1956, Anderson and Nelson 1958, Andersen and Fleharty 1964, Long 1965, Kilgore 1969, Sharps 1977, Egoscue 1979, Hines 1980). Reported observations were increasing in the 1950s and 1960s, a trend that continued into the late 1970s and 1980s (Long 1965, Blus et al. 1967, Pfeifer and Hibbard 1970, Van Ballenberghe 1975, Moore and Martin 1980, Floyd and Stromberg 1981, Zumbaugh and Choate 1985, Lindberg 1986, Schmitt 1995, *also see* Sovada and Scheick 1999). The return of swift foxes in areas of their historical distribution was attributed to cancellation of all registration of predicides (U.S. Fish and Wildlife Service 1978), declines in fur value resulting in less trapping, and restrictions on methods of fur harvest (Kilgore 1969). Floyd and Stromberg (1981) suggested an additional factor could be the significant decline in the number of farms and ranches and thus, reduction in human activities detrimental to foxes.

Distribution data, largely gathered by the Swift Fox Conservation Team (SFCT; comprised of biologists representing state and federal wildlife conservation agencies, *see* "State Agencies Response to Federal Actions" below) in the mid to late 1990s, indicated a more extensive distribution than estimated by the U.S. Fish and Wildlife Service (USFWS, Federal Register 1995), particularly in the core of the species, historical range (i.e., Colorado, Kansas, and southeastern Wyoming) and other parts of the historical distribution (see SFCT Annual Reports 1996-99).

Results of swift fox surveys by the SFCT, on a county-by-county basis, confirmed that swift fox populations in this core area, which includes a significant portion of the current range, are likely not isolated, although densities vary from region to region (Sovada and Scheick 1999). However, some populations likely are isolated, especially in Montana and parts of Wyoming (Merrill et al. 1996, Redmond et al. 1998).

The updated information indicated that swift fox populations currently occupy a substantial portion of their historic range, and possibly have reoccupied some of their former habitat throughout nearly all of the historic range in Wyoming, eastern Colorado, and several counties in the western one-third of Kansas. Evaluations in New Mexico and Oklahoma indicated that swift foxes are present throughout most of their former range. Swift fox populations appear to be reoccupying and expanding in at least 2–3 counties in north-central Montana with increasing confirmed and unconfirmed reports in 2–3 southeastern counties. Texas has been able to confirm swift fox presence in at least 3 counties in the northern panhandle. It is believed that swift fox populations continue to be absent from North Dakota, are declining in South Dakota, and are present in minimal numbers in at least 2–3 counties in western Nebraska. Some populations where swift fox are reoccupying viable habitats or have been recently reintroduced (e.g., Blackfeet Indian Reservation in Montana, Giddings 1998) may still be isolated.

Potential Threats to Populations

Present or Threatened Destruction or Modification of Habitat

The USFWS (Federal Register 1995) estimated that 45% of the swift fox's habitat throughout its historic range has been lost as a result of prairie conversion based on Soil Conservation Service (1989) data. Where native prairies remain, they often are fragmented into smaller and isolated areas, reducing available habitat and prey while increasing predation and competition for swift foxes. These remnant prairies are not the same ecosystems that were present prior to European settlement of the region. Replacement of bison with domestic livestock and the suppression of fire have resulted in changes in plant community composition and landscape patterns (Bragg and Steuter 1996, Weaver et al. 1996). Agriculture, residential development, and other commercial development have been pervasive in the shortgrass and mixed-grass prairies and are considered a cause of population declines, yet swift fox populations are relatively widespread. However, the further expansion of cultivated acreage beyond the sustainable land base onto lands that are marginal for agricultural purposes, poses a severe threat to remaining swift fox habitat. For example, the changeover from dryland agriculture systems to irrigated crops that is occurring in western Kansas could potentially have a substantial and negative impact on swift fox populations although the extent of the impact is yet to be examined. We make this speculation based on the use of fallow fields by swift foxes as sites for dens and foraging and on their limited use of irrigated croplands, such as corn (M. Sovada, unpublished data). With the continuing development of irrigated crop systems, the presence of fallow fields will be lost, which potentially could impact swift fox populations. Further investigation is needed to verify this speculation. Moreover, the planting of tall dense vegetation in fields enrolled in the Conservation Reserve Program, which is common in western Kansas, also may have negative impacts overall on swift fox populations because swift foxes avoid this tall dense perennial cover (M. Sovada, unpublished data).

Distribution and occurrence has been confirmed in a large number of counties throughout the species' historic range since 1995 (Sovada and Scheick 1999), particularly in the states of Colorado, Kansas, New Mexico, Oklahoma, and Wyoming. These states are considered to be the species' current core area and may be contributing swift foxes to adjacent states. The species' distribution is relatively widespread; however, distributions and associated densities appear to be highly variable among the 9 occupied states (Swift Fox Conservation Team 1997a). Although it is generally agreed that the swift fox evolved in the shortgrass and mixed-grass prairie ecosystem and numerous studies have provided qualitative ecological data, definition of range-wide habitat requirements in an altered landscape has not been adequately addressed.

Habitats within the shortgrass and mixed-grass prairie ecosystems are recognized as being able to provide the "essentials" of a diverse prey base, level to slightly undulating topography which affords long viewing distances to detect predators, and firm, friable soils that are suitable for the excavation and maintenance of multiple den sites for year-round use. Habitats in today's altered landscapes can vary significantly, and their suitability for swift foxes are difficult to define. The swift fox has adapted to a variety of habitat types, including the establishment of populations in a mixture of agriculture and rangeland. Kilgore (1969) and Hines (1980) reported swift fox populations inhabiting habitats of mixed agricultural use in Oklahoma and Nebraska, respectively. In western Kansas, swift foxes are commonly found in cropland-dominated landscapes, which included fragments of shortgrass prairie, but are largely comprised of fallow cropland, wheat, sunflower, and irrigated crop fields (Fox and Roy 1996, Sovada et al. 1998, Jackson and Choate 2000). However, not all habitats are used by swift foxes in proportion to their availability (M. Sovada, unpublished data). Jones et al. (1987) and Jackson and Choate (2000) found swift foxes denning in fallow cropland fields. In Wyoming, Woolley et al. (1995) found swift foxes in shortgrass, mixed-grass, sagebrush-

grassland, and sagebrush-greasewood habitat types with topography ranging from flat to badlands-like terrain. In Montana, no den sites were observed in any habitat other than native rangeland, but 1 capture out of 16 occurred in mixed habitat during the 1996 trapping efforts (Giddings and Zimmerman 1996). Paradoxically, a recent study in New Mexico did not document the use of mixed agricultural/rangeland habitats by swift foxes (Harrison and Schmitt 1997).

The conversion of native grassland prairies has been implicated as one of the most important factors for the contraction of the swift fox range (Hillman and Sharps 1978). We believe that alteration of the landscape likely influences local and seasonal prey availability, increases risk of predation on swift foxes, and leads to interspecific competition with other predators such as the coyote and red fox. However, in Kansas and perhaps portions of Oklahoma and Colorado, a mixed agricultural/rangeland landscape does not appear to necessarily diminish the habitat value of associated grasslands from a forage availability standpoint. In fact, Kansas biologists believe that agricultural systems on privately owned lands are crucial to swift fox conservation because publicly owned lands in Kansas are either too small or inadequate to support swift fox populations (C. Roy, Kansas Department of Wildlife and Parks, Emporia, personal communication). The SFCT has suggested that "it is not solely the conversion of prairie to cropland that hinders current swift fox restoration efforts but also juxtaposition of the remaining prairies, management of rangelands, cropping patterns of farmlands, and changes in canid communities that occur in response to the conversion of prairie habitat to cropland" (Swift Fox Conservation Team 1997a).

Just as farm policies of the past have encouraged conversion of native prairies to cropland (Baydack et al. 1996), farm policies of the future could impart restoration of habitat suitable for swift foxes. The Conservation Reserve Program (CRP) established under the 1985 Farm Bill and renewed under the 1996 extension has stimulated conversion of millions of croplands to perennial grassland cover (Young and Osborn 1990). However, in many areas of the shortgrass prairie, CRP fields were planted to tallgrass prairie species or non-native grasses (Sovada et al. 2003). When these fields are not grazed, mowed, or burned, they develop dense tall stands of grasses that are not suitable for use by swift foxes (Swift Fox Conservation Team 1997a). Current regulations for CRP lands do not provide adequate habitat guidelines that would benefit swift foxes. New CRP guidelines could provide incentives for participants in the CRP to plant native shortgrass species that are better suited for use by swift foxes.

Recreational/Commercial Harvest

Determining the magnitude and significance of harvest on swift fox populations as a result of trapping, hunting, predator control, and other activities has been difficult because of limited data available across the species' range. Although we acknowledge that private predator control activities result in swift fox mortalities, it is unknown if these activities are a major source of mortality that directly impacts local populations. Predator control activities conducted by the U.S. Department of Agriculture (Wildlife Services) targeting coyotes are responsible for a relatively small percentage of swift fox incidental take and may in fact be benefitting some local populations. Many wildlife biologists concur that annual mortality resulting from these activities is a very small percentage of total swift fox mortality (Swift Fox Conservation Team 1997a). In some parts of the swift fox range, where mortality may be exceptionally high as a result of predation or other factors, incidental harvest could become a concern when considered from a cumulative aspect. However, studies conducted in different parts of swift fox range have confirmed that predation by coyotes is the most significant mortality factor (Laurion 1988, Carbyn et al. 1994, Sovada et al. 1998, Kitchen et al. 1999). Additional interspecific competition with red foxes may exacerbate this problem (Ralls and White 1995; M. Sovada, unpublished data). Currently, 2 studies are being conducted to examine the impact of coyote control on swift fox populations (Mote et al. 1998, Seidel 1998).

Swift foxes are legally protected under State laws in all 10 states which encompass the species' historical range and are currently protected from harvest through laws or regulations in 7 of these states (Swift Fox Conservation Team 1997a). States that do provide harvest opportunities regulate harvest by season length and monitor harvest numbers annually. Kansas, New Mexico, and Texas provide a regulated harvest season and estimate annual harvest figures. Colorado, Montana, North Dakota, and Oklahoma list swift fox as furbearers but the harvest season is closed all year. Nebraska lists swift fox as "endangered," and in South Dakota they are "threatened." Wyoming lists swift fox in their nongame regulations, and only incidental harvest is allowed to provide additional distribution data. Trapper education programs are becoming more available to fur harvesters, and fur harvester education courses are currently required in several states, which SFCT believes may help to reduce incidental harvest across the swift fox range.

There is insufficient information to weigh the impact of harvest on swift fox distribution or population densities; therefore, the importance of harvest in limiting or regulating swift fox populations is unknown. The evidence available suggests that regulated harvest has had no impact in limiting swift fox populations. For example, swift fox populations in Colorado have remained widespread despite 55 years of regulated harvest. No noticeable reduction in distribution has occurred in Kansas since the opening of a trapping season on swift fox in 1982. In comparison, swift

fox have been protected from harvest in South Dakota, Nebraska, and Oklahoma, with no apparent increase in distribution or population densities during the same period. Further, pelt prices during the last 10 years have remained low, varying from $3 to $10 (U.S. currency, Swift Fox Conservation Team 1997a). Thus, there is little interest or incentive to actively harvest swift fox. Most swift fox are taken incidental to coyote trapping activities and are not considered a target species.

Disease and Predation

Parasite and disease agents in wild swift fox populations have not been extensively studied; however, there is no indication that parasites or diseases are significant factors in the population dynamics of wild foxes. It is believed that swift foxes share a community of parasites and diseases with sympatric canids and have not developed a specialized suite of agents. Various disease agents have been documented serologically (e.g., sylvatic plague and canine distemper) (Pybus and Williams 2003); however, there are few cases of confirmed overt diseases in wild swift foxes. One report of canine distemper was reported in Wyoming in 1999 (T. Olson, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, personal communication).

Although predation by mammal and avian predators such as American badgers and golden eagles has been documented (Carbyn et al. 1994, Andersen et al. 2003), predation by coyotes is the most important natural mortality factor for swift fox populations in the United States and the reintroduced populations in Canada (Laurion 1988, Covell 1992, Carbyn et al. 1994, Sovada et al. 1998). The reported annual mortality rates (range from 0.47 to 0.57; Covell 1992, Sovada et al. 1998, Andersen et al. 2003) may seem high, yet they are similar to rates reported for other North American foxes (Lord 1961, Storm et al. 1976, Cypher and Scrivner 1992, Disney and Spiegel 1992, Ralls and White 1995). It has been suggested that potentially high reproductive rates may compensate for high mortality rates (Sovada et al. 1998). In many situations, control of coyotes may enhance distribution and abundance of swift fox populations. However, managers should proceed cautiously. Cypher and Scrivner (1992) evaluated reduction of coyote numbers to increase kit fox survival but were unsuccessful in reducing coyote numbers sufficiently to affect kit fox populations.

Other Natural or Man-made Factors

Predation by and interspecific competition with coyotes and expansion of red fox populations may be the 2 most serious limiting factors to swift fox recolonization of suitable habitat identified within the species' historic range. Sovada (1995), in a discussion of future research needs, stated that "significant changes in landscape (increased agriculture, lack of corridors) may result in increased risk of predation. Competition with coyote and red fox confer a likely ecological barrier for settling into new areas." Coyote killing of swift foxes significantly affected efforts to reintroduce swift foxes in Canada (Scott-Brown et al. 1986, Carbyn et al. 1994). The relationship between red foxes and swift foxes is unknown, although preliminary data analysis of an experimental study examining this relationship suggests that red foxes are a barrier to swift fox populations expanding into unoccupied, but suitable, areas (M.A. Sovada, unpublished data). Ralls and White (1995) reported that although coyote predation on kit foxes can be severe, red foxes may pose an even greater threat to kit fox populations because where red foxes rapidly moved into areas occupied by kit foxes, the red foxes appeared to displace the kit foxes. This observation of kit fox–red fox relations may serve as a model for the relations between the swift fox and red fox. Based on known interspecific relationships between other canids, the red fox may be a substantial barrier to swift fox range expansion and may be more detrimental to swift foxes than coyotes (Ralls and White 1995). Without understanding interspecific relations between the swift fox and red fox, we risk ineffective or possible failure of management programs and loss of time and funds, which may compromise the conservation of the swift fox.

Swift foxes are frequently observed along roadways. Several studies have indicated that swift foxes frequently use roadways as travel lanes and for foraging activities, and they may build dens nearby (Hines and Case 1991, Pruss 1999). These roadway associations can be major sources of vehicle-related mortality for juvenile foxes (Sovada et al. 1998). The significance of this mortality factor to the overall question of maintaining population viability has not been studied in any detail. Vehicle-caused mortality does not appear to be a significant adverse problem from a range-wide perspective. In Kansas, where road densities are fairly high, state biologists believe that factors such as road densities, distance traveled, and driver speed may increase the rate of swift fox mortalities. Kansas has for several years utilized vehicle-caused mortalities per unit time as a means to calculate population trend index. However, annual road mortalities in Kansas do not appear to be affecting distribution and status of this species (C. Roy, personal communication).

It is generally accepted that the widespread use of strychnine intended to kill wolves and coyotes was the major cause of decline in swift fox populations in the 1800s (Scott-Brown et al. 1987). Significant changes have occurred in predator-control programs since the days of indiscriminate use of strychnine and compound 1080. Federal and State predator-control methods during the 1950s replaced non-selective poisons like strychnine with more selective toxicants, contributing to a rebound of swift fox populations in the 1960s through the early 1980s. Also, the 1972 Presidential ban (Executive Order 11643) on predator toxicant use (strychnine, compound 1080,

etc.) on Federal lands is considered to have been a positive factor to swift fox conservation. Further, current Federal and State predator-control programs have developed selective techniques, such as pan-tension devices, snare stops, and bait placement techniques, in an attempt to exclude swift fox from traps. The U.S. Department of Agriculture maintains records of the number of swift fox killed during Federal predator control activities, and swift foxes comprise a very small percentage of total mortalities (U.S. Department of Agriculture, Wildlife Services; unpublished data).

Legal predator control activities conducted by private individuals and landowners using leg-hold traps, snares, and shooting also occur, although the magnitude and range-wide effect of these types of measures is unknown. However, it also must be acknowledged that illegal control of predators through the use of carcasses of livestock laced with insecticides, toxicants, or banned chemicals still occurs throughout the western Great Plains. These methods are nonselective in nature and take a wide variety of wildlife species such as coyote, red fox, bald eagle (*Haliaéetus leucocéphalus*), and golden eagle, and it is believed that swift fox mortalities do occur as a result of primary or secondary contact (*see* Sovada et al. 1998). Unfortunately, the extent or magnitude of this problem relative to overall swift fox population viability is unknown but probably varies in any given year depending on the perceived level of the depredation problems.

Rodent control activities, specifically prairie dog control actions which have eliminated 98% of the historic population levels (Marsh 1984), may have had adverse impacts on swift fox populations in the northern portion of their distribution. This does not appear to be the case in Wyoming, Colorado, and in the majority of states in the southern portions of the species' range. Studies indicate that the swift fox, as an opportunistic forager, successfully adapts its diet to availability of food items, and research has documented diets high in insects, vegetation, certain agricultural crops, and a variety of small birds and mammals (Cutter 1958a, Kilgore 1969, Zumbaugh et al. 1985, Uresk and Sharps 1986, Hines and Case 1991, Kitchen et al. 1999, Sovada et al. 2001). In South Dakota, where some of the most viable black-tail prairie dog (*Cynomys ludovicianus*) populations in the country remain, a close association between the swift fox and the prairie dog has been reported (Hillman and Sharps 1978, Uresk and Sharps 1986); here the prairie dog ecosystem may have provided a stable, year-round source of food in northern portions of the species' historic distribution. In the north, where climatic conditions and the duration of temperature extremes are generally regarded as being more harsh and pervasive, the prairie dog ecosystem may have had greater importance to the long-term stability and viability of swift fox populations. However, it is apparent from the studies done by SFCT and the individual States during the past 3 to 5 years that swift fox populations in today's altered landscape are not necessarily dependent upon the availability of prairie dog towns and complexes (Cutter 1958a, Kilgore 1969, Zumbaugh et al. 1985, Hines and Case 1991, Kitchen et al. 1999). Prairie dogs were largely absent or at best rare in areas of Canada that were historically occupied by swift foxes (Banfield 1974).

Summary of Federal and State Governments' Actions in the United States

Federal Action

On 3 March 1992, the USFWS received a petition requesting that the swift fox be listed as an endangered species in the northern portion of its range, if not its entire range, in the United States. The petitioner asserted that swift foxes once occurred in abundant numbers throughout the Great Plains; however, concurrent with settlement of the region, populations declined and the species is now considered rare in the northern portion of its range. The petitioner indicated that the swift fox was extremely vulnerable to human activities such as trapping, hunting, automobiles, agricultural conversion of suitable habitat, and prey reduction from rodent control programs. The petitioner requested that, at a minimum, the swift fox be listed as an endangered species in Montana, North Dakota, South Dakota, and Nebraska. Justification for such action as cited by the petitioner includes the present status of the species and its habitat in the petitioned area, the strong link to the prairie dog ecosystem, the large distance from the kit–swift fox hybrid zone, and the potential for these populations to contain the northern subspecies of swift fox (*Vulpes velox hebes*).

The general deficiency of data on the current status and distribution within the species' historic range, limited biological information on the species, and insufficient genetic data to confirm the occurrence of both a northern and southern subspecies of the swift fox resulted in an unusually long initial review process. A 90-day finding was published (Federal Register 1994) on 1 June 1994. On the basis of the best scientific information available at the time, the USFWS found that listing the swift fox was warranted throughout its entire range, but listing was precluded by work on other species that had higher priority for listing. The notice indicated that the USFWS would conduct a status review of the swift fox and requested that any additional information on the status, population, trend, distribution, and habitat use of this species be submitted to the Field Supervisor (USFWS, Pierre, South Dakota).

A notice of a 12-month petition finding was published (Federal Register 1995) on 16 June 1995, announcing that the USFWS had determined that listing of the swift fox was warranted but precluded by higher priority actions. The species' status was elevated from a Category 2 to a Category 1 species, and a listing priority of 8 was assigned

based on a perceived low- to medium-magnitude of threats and the immediacy of actual threats to the species. The USFWS estimated that the swift fox had been extirpated from 80% of its historical range, and that remaining populations existed in scattered, isolated pockets of remnant shortgrass to mid-grass prairie habitats. Seventy to 75% of remaining swift fox populations were believed to reside on private lands, with the remaining populations on Federal lands belonging to the U.S. Forest Service, the National Park Service, the Bureau of Land Management, and the Department of the Army (Federal Register 1995). The status of the swift fox was changed by the USFWS to a listing priority of 9 in September 1997 (Federal Register 1997). Additionally, processing of a final determination on the proposed rule to list the swift fox was delayed by the moratorium on final listings imposed on 10 April 1995 (Public Law 104-6), and the development of the USFWS's listing priority guidance (Federal Register 1996) to clarify the order in which they process rule makings.

State Agencies Response to Federal Actions

In response to the 90-day Administrative Petition Finding, on 1 August 1994, the Directors of the 10 state wildlife agencies (Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming) affected by the finding sent a letter to the USFWS indicating their belief that an error had been made in the 90-day finding, both in omission of key information and in a lack of rigorous analysis of the existing data. The letter identified 2 key points that were omitted from the 90-day finding: (1) both the range and the distribution of the swift fox have increased over the past 30 years, although the distribution is less than the presumed distribution prior to settlement; and (2) more than 75% of swift fox habitat is on private property, and although recognizing that land status is not a consideration for listing, a practical assessment of this situation suggests that landowner practices could have significant effects on swift fox populations. In their letter, the Directors described their commitment to developing a Conservation Strategy Plan as a cooperative venture that would pool resources and seek to develop a regional management plan.

In October 1994, the 10 affected state wildlife management agencies and interested cooperators (several Federal agencies, including the USFWS) formed the Swift Fox Conservation Team. The goal of the SFCT was to develop a Conservation Assessment and Conservation Strategy (CACS) document for the swift fox. The CACS was intended to provide the framework to direct swift fox conservation as an alternative to a federally mandated recovery effort.

On 29 December 1994, the USFWS received a draft CACS from the SFCT, which outlined short- and long-range goals, objectives, and strategies for management of the swift fox throughout its range. The CACS, similar to a long-term recovery plan with a number of prioritized objectives and strategies, is considered a working document which will be modified annually based on SFCT accomplishments and data needs. That is, objectives and strategies are prioritized and accomplishment dates are set based, in part, on the USFWS's recommendations and suggestions to the SFCT; accomplishments are reviewed and reported on an annual basis. According to the CACS, attainment of conservation strategy objectives is intended to be accomplished by 2015 if adequate funding and resources are available.

The primary objective of the SFCT during the late 1990s was to compile and collate current distribution, occurrence, and status data while attempting to develop standardized survey methodology that may be applied across the range of the swift fox (see Swift Fox Conservation Team Annual reports 1995, 1996, 1997b, 1998, 1999, and papers in 2002). In some states such as Colorado, Kansas, Montana, New Mexico, Texas, and Wyoming, biological data have been collected about natal dens, territories and habitat selection, food habits, dispersal, litter sizes, recruitment, mortality, and survey techniques.

Although only limited data are available to project short- or long-term population viability of swift foxes on a range-wide basis, recent observations indicate the presence of numerous connected populations across a large portion of the historic range. Evaluations conducted by the SFCT have demonstrated nearly continuous distribution of swift fox populations from Wyoming south throughout eastern Colorado, western Kansas, the Oklahoma panhandle, eastern New Mexico, and in 3 counties in the extreme northern panhandle of Texas. Scattered populations of swift fox can be found in Montana, South Dakota, and Nebraska. In Montana, 2 of the 3 areas where swift foxes occur are the result of either reintroduction efforts or recolonization and emigration from reintroduced populations in southern Saskatchewan and Alberta, Canada. In August 1998, The Defenders of Wildlife, the Blackfeet Indian Reservation, and the Cochrane Wildlife Reserve in Alberta, Canada, initiated a swift fox reintroduction effort within the Blackfeet Indian Reservation in Glacier County.

In 2001, the USFWS reviewed the status of swift fox populations and determined that the magnitude and immediacy of threats to the species were not such that warranted listing under the Endangered Species Act (Federal Register 2001). The ruling submitted that the continuity of populations indicates an apparent viability and vitality which demonstrates that the magnitude and immediacy of threats to the species may have been sufficiently reduced to a level that precludes the necessity of listing. However, vigilance in monitoring populations is recommended to ensure conservation of swift foxes. Recognizing the need for vigilance, state and federal agencies have reaffirmed their commitment to accomplishing the goals established

in the CACS, and their support of necessary conservation actions that ensure healthy populations of the swift fox.

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In 1998, biologists and endangered species experts from fifteen states, three provinces, and seven countries met at an International Symposium on Swift Foxes, held in Saskatoon, Saskatchewan, to exchange information and identify the "state-of-the-science" of swift fox ecology and status in North America. Papers presented at the symposium, together with others written afterwards, are brought together in this peer-reviewed volume, which is divided into five major sections. Papers in Part I (Setting the Stage) consider swift fox conservation issues in general. Part II (Distribution and Population Shifts) explores what is known about the current distribution of the species on the North American continent. Part III (Censusing and Techniques) is devoted to evaluations of scent stations for surveying fox presence and abundance, along with a review on mitigating capture-related injuries. The papers in Part IV (Population Ecology) attempt to better understand the dynamics of changes in distribution and abundance of swift foxes on the continent, particularly as related to loss of suitable habitats, ecosystem modification brought on by human activities, and climate change. Part V discusses the current knowledge of swift fox taxonomy, physiology, and disease-related issues. Broad-ranging and comprehensive, *The Swift Fox: Ecology and Conservation of Swift Foxes in a Changing World* will provide invaluable information for scientists, resource managers, and students.

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- A Review of the Ecology, Distribution, and Status of Swift Foxes in the United States
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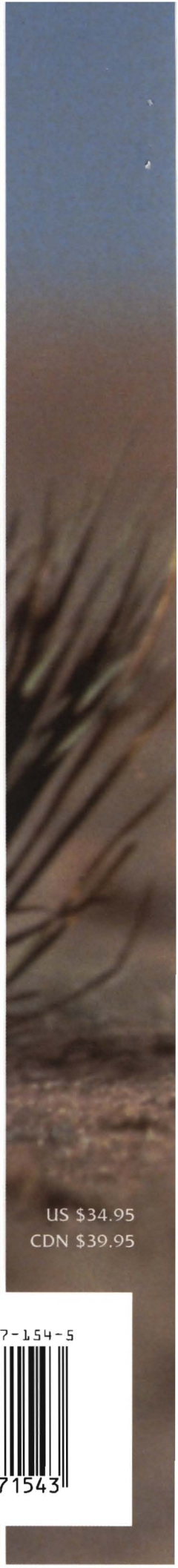

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